INSTALLATION

The phone jack audio input accepts a three-conductor (tip-ring-sleeve) phone plug and is wired in parallel with the XLR input. The input signal connections are as follows:

Signal, high: pin 3 on XLR, tip on phone plug
Signal, low: pin 2 on XLR, ring on phone plug
Ground: pin 1 on XLR, sleeve on phone plug

The inputs may also be used with unbalanced lines by tying pin 2 of the XLR connector to pin 1 or by simply using a two-conductor (tip-sleeve) phone plug.

Its high input impedance (20 k ohms, balanced) allows the Dual Limiter to be used with a wide variety of sources, while its low output impedance (200 ohms) enables it to drive long lines and any reasonable input impedance. The Dual Limiter is intended for use with line level signals (approx. 0 dBm average signal level). A preamplifier should be used with lower-level devices such as musical-instrument pickups to bring their levels up to line level.

The rear panel also includes jacks which permit access to each section's detector loop. The DETECTOR LOOP jacks accept standard two-conductor 1/4" phone plugs. These jacks may be used to obtain different compression slopes with external patching, or a vocal may be de-essed by using an equalizer in the loop. These and other applications are discussed in more detail in the Applications section. When these additional capabilities are not desired, the DETECTOR LOOP jacks should be left unconnected.

The Dual Limiter operates from a power source of between 90 and 130 volts AC, 50 - 60 Hz. Models manufactured for use outside the United States have been modified to comply with the required electrical specifications for the country of destination.

The MXR Dual Limiter provides a comprehensive set of controls, clearly labeled, and designed for maximum flexibility and ease of use. The following discussion explains the function of each control. The front-panel diagram, Figure 2, is provided for convenient reference. Note that, with the exception of the POWER and STEREO/DUAL switches, both sections of the Dual Limiter have an identical set of controls which function in exactly the same manner.

POWER Switch

The switch labeled POWER turns the Dual Limiter on or off. The LED above the button is lit while power is applied. There is a short delay after turning the unit on before its outputs are enabled. This protects other equipment connected to it from potentially damaging turn-on transients. The outputs are also muted when the unit is turned off or the AC power to the unit is interrupted.

IN/OUT Switch

The IN/OUT switch determines whether the Dual Limiter's internal circuitry is in or out of the signal path. Pushing the button in connects the limiting circuitry. Pushing the button again returns it to the out position and bypasses all

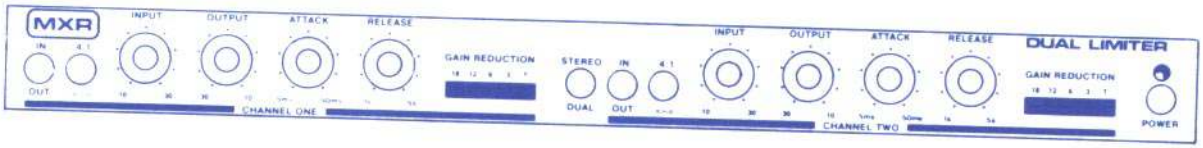


Figure 2

active circuitry, connecting the output jacks directly to the corresponding input jacks. Thus the unit will always pass a signal when bypassed even without AC power.

4:1/∞ Switch

The position of this switch determines the compression/limiting slope of the Dual Limiter. Pushing this button in selects a 4:1 slope. This means that, with a signal level above the limiting threshold, a 4 dB change in input level will produce a 1 dB change in output level. Pushing the button again returns it to the out position and selects an "infinite" (∞) slope. This means that, while in limiting, the output level will remain essentially constant no matter how much the input signal level changes. Note that the output level may suddenly increase during heavy limiting when switching from an ∞ slope to a 4:1 slope.

Refer to Figure 3 for a graph showing curves of output level versus input level with the Dual Limiter bypassed and for various compression/limiting slopes. The 1.6:1 and 2:1 slopes are obtained by externally patching the detector loop as discussed in the Applications section.

INPUT Control

The INPUT control adjusts the input sensitivity of the Dual Limiter. The panel markings indicate the minimum level of input signal required to reach limiting (i∞ slope selected). The Dual Limiter is least sensitive with the control fully counterclockwise. In this position, input signals below +10 dB will not be limited. Turning the control clockwise makes the unit more sensitive. In the fully clockwise position, signals above —30 dB will be in limiting. By using the minimum INPUT setting possible, noise at the output of the Dual Limiter will be minimized.

The INPUT control acts as a level control for signal levels below the limiting threshold.

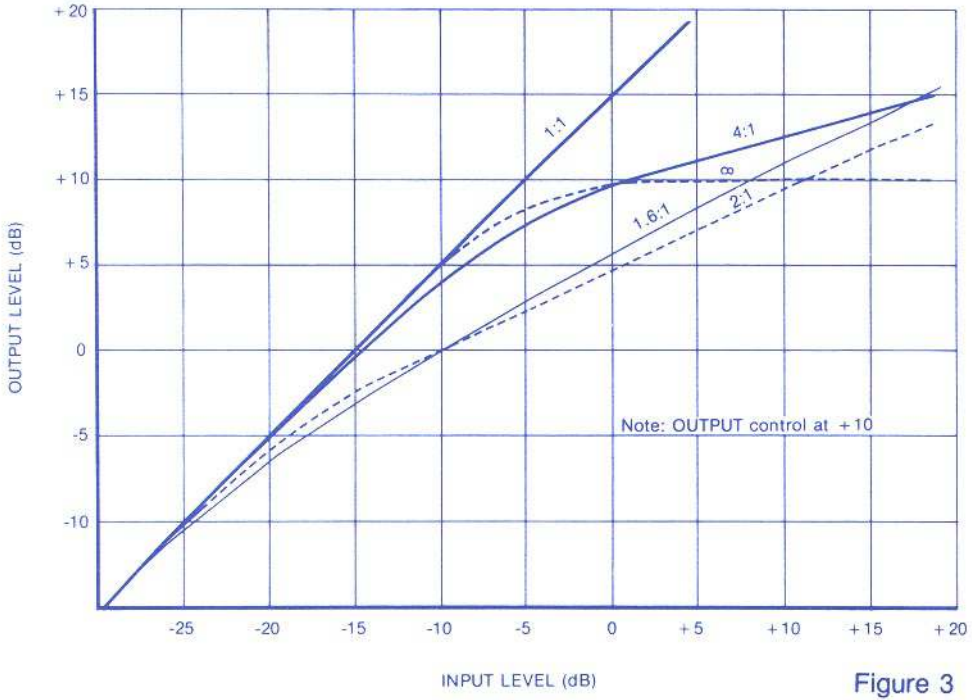

+20
+15
+10
+5
0
-5
-10
OUTPUT LEVEL (dB)
1:1
4:1
∞
1.6:1
2:1
Note: OUTPUT control at +10
-25
-20
-15
-10
-5
0
+5
+10
+15
+20
INPUT LEVEL (dB)

Figure 3

OPERATION

OUTPUT Control

The OUTPUT control adjusts the output level of the Dual Limiter. The panel markings indicate the maximum continuous output level (∞ slope selected). The instantaneous output level may be as much as 20 dB above the continuous level up to the rated maximum output level of the unit. With the control fully counterclockwise, the output level for a signal in limiting will be —30 dB. Turning the control clockwise increases the output level. In the fully clockwise position, the output level will be +10 dB for a signal in limiting.

As mentioned, the markings are calibrated assuming an infinite slope. However, as a point of reference, the markings also correspond to the specific case of a signal with approximately 6 dB of gain reduction when the 4:1 slope is selected.

ATTACK Control

A compressor/limiter controls signal levels by changing the gain of an internal voltage-controlled amplifier or VCA. The ATTACK control varies the time it takes to change the VCA gain in response to changes in input signal level. This control may be viewed as a "coarse" adjuster of attack time while the internal circuitry provides automatic "fine" adjustment, depending on how much the input signal level changes. The greater the change in signal level, the shorter the attack time is.

The panel markings apply when gain changes greater than 3 dB are required. For gain changes less than 3 dB, the shorter attack times are lengthened. For example, the shortest attack time is selected by turning the control fully counterclockwise. In this position, the attack time is 0.5 ms (millisecond) for large changes in level and 10 ms for small changes. Turning the control clockwise lengthens the

attack time. In the fully clockwise position, the attack time is 50 ms (for any change in level, large or small).

RELEASE Control

The RELEASE control varies the time it takes for the VCA gain to recover towards unity gain in order to respond to further changes in input signal level. Release is to the average level of the source material. This feature allows you to select relatively fast release times without paying the penalty of increased distortion with continuous low-frequency material.

Turn the control fully counterclockwise to select the shortest release time (0.1 second or 100 ms). Turning the control clockwise lengthens the release time. In the fully clockwise position, the release time is 5 seconds.

GAIN REDUCTION Display

Although the display is not a control per se, it deserves some explanation at this point. The LEDs give an accurate indication of the Dual Limiter's effect on the signal. The display is always activated, independent of the position of the IN/OUT switch, so the controls may be adjusted and monitored with the unit out of the signal path.

The LEDs light sequentially from right to left. The lighting of each successive LED indicates that at least that amount of attenuation or gain reduction is occurring. For example, when the rightmost or threshold LED (labeled "T") lights, it indicates that the unit is attenuating the signal by at least 1 dB. Stated in another way, the signal is at least 1 dB into limiting. Likewise, when the LED labeled "3" lights, the signal is at least 3 dB into limiting. The display provides greater resolution at lower levels of gain reduction.

All of the display LEDs will dim when the

maximum gain reduction of the unit is approached. This indicates that the input is near overload and that the input sensitivity should be reduced somewhat by turning the INPUT control counter-clockwise.

STEREO/DUAL Switch

Until now, we have been talking about the Dual Limiter as if it were two completely independent units. This is exactly how the unit operates with the STEREO/DUAL switch in the out (DUAL) position. There is no interaction between the controls of each channel when in the dual mode.

However, when processing stereo signals, it is desirable to have both channels operate in a related manner to prevent unwanted shifting of the stereo image. This is accomplished by pushing the switch in (STEREO position). In the stereo mode, the VCA control voltages of both channels are connected together so that both channels respond in the same manner. For proper stereo operation, the positions of the slope (4:1 / ∞) switches should be the same for both channels. The settings of the INPUT, RELEASE, and ATTACK controls (in decreasing order of importance) should also be about the same for both channels. This will ensure that one channel is not overly dominant in determining how the stereo signal is processed. The OUTPUT controls affect the level balance between the two channels.

This discussion is intended to help you more fully understand the operation of the MXR Dual Limiter. Your specific application will determine the actual control settings and their actions. We encourage you to experiment with the many creative possibilities the Dual Limiter provides. The Dual Limiter cannot be harmed by any combination of control settings. The following application notes assume that the POWER and IN/OUT switches are in.

The dynamic response of the Dual Limiter is controlled by the ATTACK and RELEASE controls. Since audio program material varies greatly, specific settings of the ATTACK and RELEASE controls will not be given. You will make these settings based upon your goals, the program material, and the potential side effects of compression/limiting. Each control has a specific function and does not directly affect the other. Suppose we are processing a drum mix consisting of kick bass, snare drum and cymbals, and that the level is high enough for limiting to occur. As the attack time is decreased, the apparent level of the snare drum is lowered in the mix, the kick bass becomes "thinner" or "less boomy," and the overall level is reduced. Continuing to decrease attack time causes loss of the "crack" of the drums and an added overall harshness. This is caused by the detector responding too quickly to peak levels in program material. At slow attack times, the Dual Limiter responds predominately to the average level of the program material. The sound is smoother but the unit responds to quick changes slowly. If being used for clipping protection, overshoots and short transients pass through the unit and may distort subsequent electronics. If the attack time is too long, the detector responds to peaks in level too slowly and transients sound overemphasized. As a rule of thumb, short attack times leave music well controlled, less dynamic and potentially "harsh." Long attack times retain or emphasize dynamics

but give less control of transients.

Now consider the RELEASE controls set for quick release. This setting increases the apparent level, changes the natural decay characteristics and reduces dynamics. If this control is set too fast, background or lower level signals are modulated, the sound becomes "uneven" or "jumpy" and typically, low frequencies become distorted. In the detector of the Dual Limiter, the release circuit prevents excessive low-frequency distortion at fast release rates. At the longest release times, dynamics are unaffected, the apparent level decreases and the Dual Limiter slowly returns to its appropriate gain after a transient. As a rule of thumb, a short release time increases the average level and decreases dynamics; a long release time maintains original dynamics, lowers the average level, and returns the Dual Limiter to the appropriate gain more smoothly.

The slope control affects the static response of input to output ratio. On the front of the Dual Limiter, a switch selects slopes of 4:1 or infinite. These slopes are plotted in Figure 3. In this discussion we will call the infinite slope "limiting" and the smaller slopes "compression." Limiting is the restriction of audio signals within certain bounds. This action is useful in controlling dynamic range while maintaining sonic clarity. To illustrate the usefulness of limiting, consider, as an example, a vocal in a PA system. Assume the microphone is about one foot away from the vocalist. The average vocal level is set 10 dB lower than the clipping point of the PA system. If the vocalist were to move within a few inches of the mic, the output level of the mic would increase significantly. This situation would certainly cause clipping of the PA system. If there is a limiter present in the system, the limiter will reduce its gain to maintain a constant output level once its threshold is exceeded. This threshold is set at a

point which will prevent clipping in the PA system. The mic level can be increased as well since any peaks will be reduced by the limiter.

Consider now the processing of a vocal in a studio. In our previous example, we used the Dual Limiter for protection. In the studio, we still want to control dynamics but will be more interested in maintaining dynamic "expression" in the vocal. To accomplish this, we use the 4:1 slope. Assume we set the INPUT control to compress the vocal all the time. If the vocalist sings 12 dB louder, the output of the Dual Limiter increases 3 dB.

Throughout much of this manual, the 2:1 and 1.6:1 slopes have been mentioned. These slopes are obtained by connecting a detector loop input to the corresponding channel audio output. Thus the infinite position of the slope switch provides a slope of 2:1 and the 4:1 position provides a slope of 1.6:1. The detector loop input threshold is fixed at -7 dB, therefore, as the OUTPUT control is increased, the output level increases for signals below threshold. However, the threshold, relative to the audio input, decreases due to the added gain of the output. Once the threshold is exceeded, the audio output level increases at the chosen slope because the increase in output gain causes the detector to reduce the VCA gain.

The Dual Limiter may be used to reduce the sibilance in a vocal track. As in a previous example, the unit is set up to compress a vocal at a 4:1 slope. One of the effects of compression is an increase in the level of "s" sounds or sibilance. To remedy this effect, insert an equalizer in the detector loop and boost frequencies between 2 kHz and 8 kHz. Since boosting levels in the detector loop **decreases** the threshold of compression, sibilance sounds are attenuated to lower levels than the remaining program material. This permits a wide variety

of "de-essing" applications.

The Dual Limiter is well suited for clipping protection in PA's. For recording studio use, the Dual Limiter can prevent distortion in reverbs and tape machines. The infinite setting of the slope switch can also be used as an effect. Limiting or compressing a guitar signal is a source of undistorted sustain. Once processed, this signal is easily recorded since the dynamic range is well controlled. This applies to many instruments, electric or acoustic. Remember, however, that in reducing dynamic range, you are increasing the level of the source's noise floor. Excessive limiting will significantly increase the noise of the program source.

On a multitrack mixdown, where we need to reduce the level of the guitar when the lead vocal is present, the guitar signal is connected to the Dual Limiter audio input and the output is infinite and the lead vocal is fed into the detector input to control the guitar level. Since the slope switch is set to infinite, when the vocal exceeds the threshold by 6 dB, the guitar level will be lowered 6 dB. Remember to adjust the ATTACK and RELEASE controls so that the modulation of the guitar is not excessive while the vocal is present.

Here is a brief description of the internal circuitry of the MXR Dual Limiter. Refer to the detailed system block diagram, Figure 4, showing how each stage is interconnected. There are three major sections: the audio signal path, the control circuitry, and the power supply. For clarity, only one of the two identical channels is shown. The power supply is common to both channels.

INPUT CIRCUITRY

The input signal from either input connector is terminated and buffered by a differential amplifier which rejects common-mode noise, hum, and RFI (Radio Frequency Interference). Next, a feedback-type level circuit incorporating the INPUT control optimizes the input signal level for the VCA and permits control of the amount of limiting. The input filter removes all signal components above 36 kHz to prevent aliasing in the VCA circuitry.

VCA

The voltage-controlled amplifier is the heart of the Dual Limiter and represents a unique approach to automatic gain control. It uses switching devices operating at 250 kHz which are pulse-width modulated to control the gain. The pulse-width modulation is proportional to the control voltage. As the input signal level increases, the control voltage will also increase proportionately. This causes the pulse width to decrease and reduces the gain of the VCA. Thus the change in output level is "limited" in relation to the change in input level.

OUTPUT CIRCUITRY

After the VCA, a four-pole output filter removes any information above 36 kHz. This filter is factory trimmed for best overall square-wave response. Next, the signal is variably attenuated by the OUTPUT control and amplified by the output amplifier, which also provides a buffered output. A muting circuit shunts the output signal

CIRCUIT DESCRIPTION

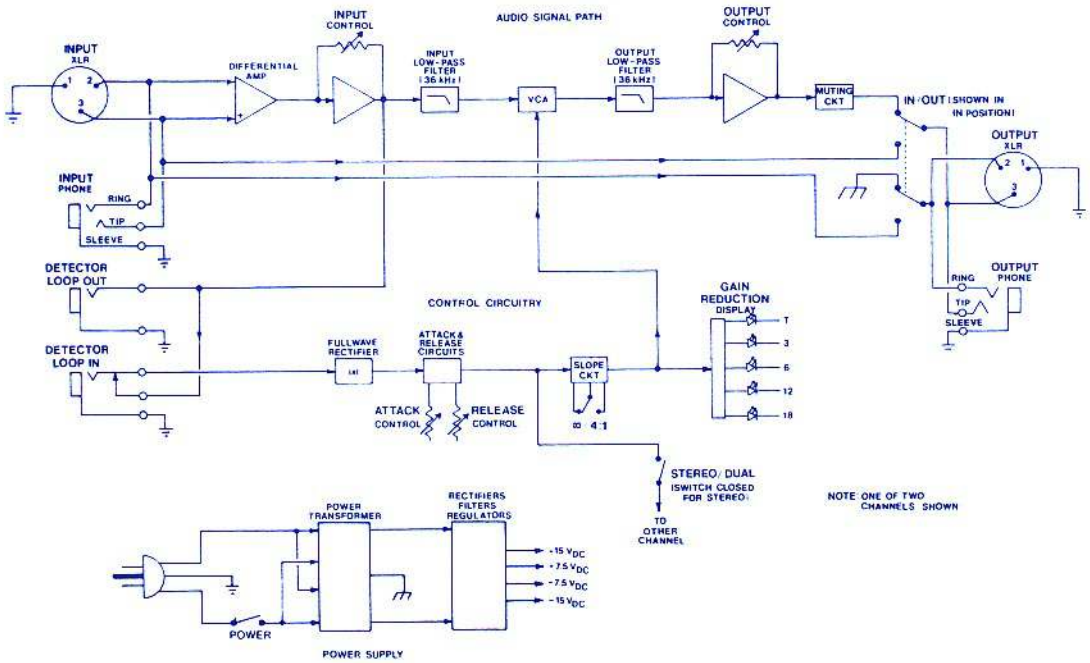


Figure 4

to ground if AC power is interrupted or the unit is turned off. The muting is also enabled for a short time after turning the unit on. This protects equipment connected to the Dual Limiter from potentially damaging transients. Finally, the IN/OUT switch mechanically ties the output connectors to either the single-ended output circuitry or the balanced input connectors.

CONTROL CIRCUITRY

The output of the input-control is fed to the control circuitry via the rear-panel DETECTOR LOOP jacks. These jacks are tied together internally when nothing is plugged into the loop IN jack. Next, the signal is full-wave rectified and processed by the attack and release circuitry. The front-panel ATTACK and RELEASE controls determine the coarse characteristics of this circuit. However, both attack and release times are automatically fine adjusted when the signal demands exceed the nominal control settings. The control voltages at this point from both channels are routed to the front-panel STEREO/DUAL switch and strapped together when the switch is in (STEREO position). The slope circuit, controlled by the front-panel slope (4:1/∞) switch, further modifies the control voltage which is then routed to the VCA. The GAIN REDUCTION display monitors this control voltage and accurately indicates the amount of gain reduction in decibels.

POWER SUPPLY

The power supply provides filtered and regulated DC voltages of ± 7.5 volts and ± 15 volts for the rest of the circuitry. It consists of a universal power transformer, a bridge rectifier, large filter capacitors, and linear voltage regulator ICs. The operating line voltage is configured for the country of destination. The front-panel POWER switch controls the application of the AC line voltage to the transformer primary. An LED above this switch is lit when power is applied.

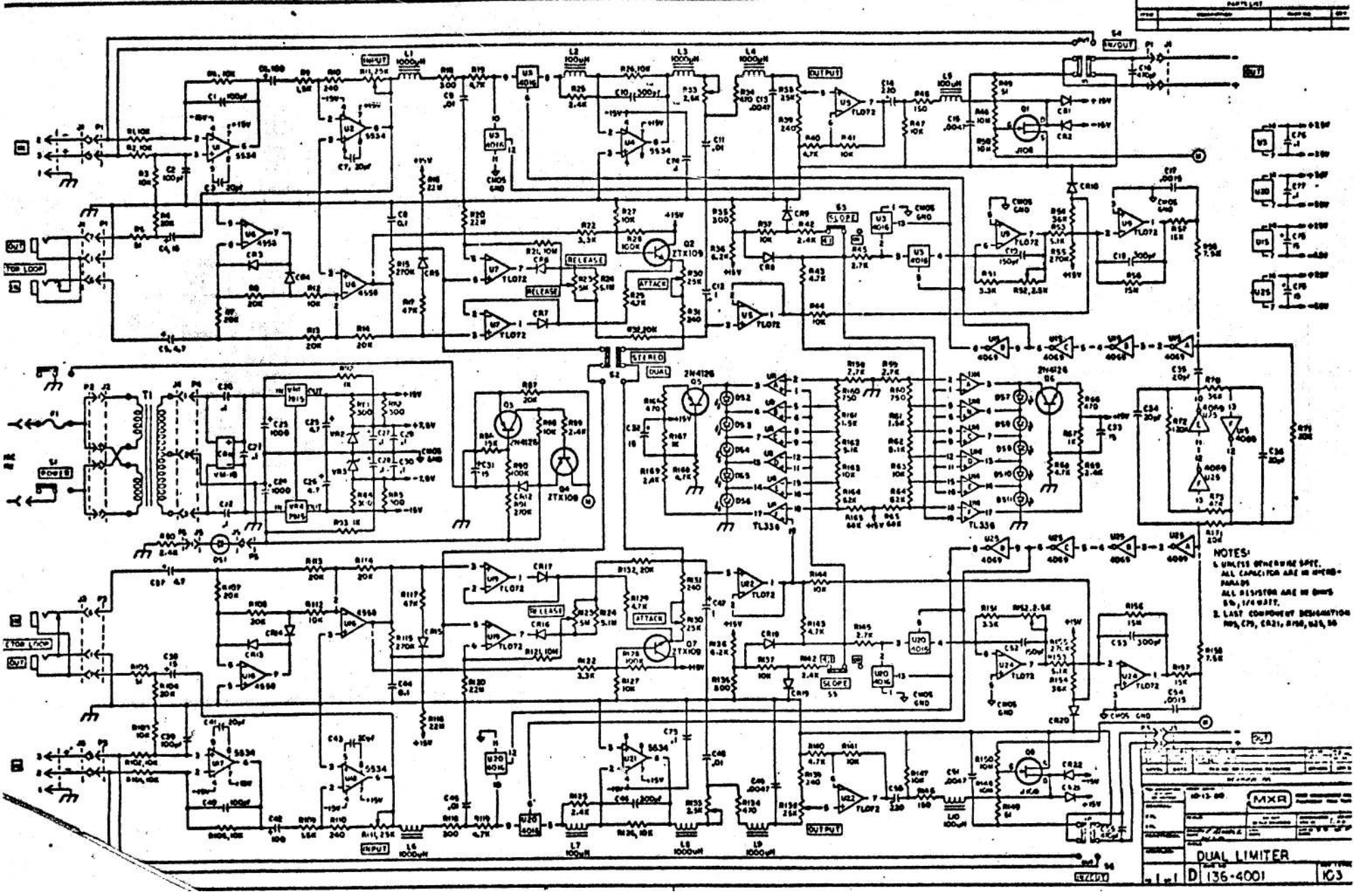
SPECIFICATIONS

Maximum Input Level	+19 dB*
Maximum Output Level	+19 dB*, +10 dB* continuous
Input Impedance	20 k ohms balanced
Output Impedance	200 ohms
Detector Loop:	
Maximum Input Level	+19 dB*
Maximum Output Level	+19 dB*
Input Impedance	10 k ohms
Output Impedance	100 ohms
Equivalent Input Noise	-100 dB*
Output Noise	90 dB below max. continuous output
Maximum Slew Rate	greater than 7 v/microsecond
T.H.D.	.05% below threshold (20 Hz - 20 kHz) 0.1% with 10 dB of limiting (20 Hz - 20 kHz)

* dB levels are referenced to .775 v. no load

SPECIFICATIONS

I.M.	.05% below threshold (60 Hz/7 kHz, 4:1) 0.1% with 10 dB of limiting (60 Hz/7 kHz, 4:1)
Frequency Response	20 Hz - 20 kHz, ±1 dB
Maximum Limiting	24 dB
Attack Time	0.5 - 50 ms
Release Time	0.1 - 5 sec
Slope	4:1 or ∞, user selectable, with smooth transition through threshold
Power Requirements	Domestic: 90 - 130 volts AC, 50 - 60 Hz, 165 ma, 18.2 watts
	Foreign: 180 - 260 volts AC, 50 - 60 Hz, 82.5 ma, 18.2 watts


DUAL LIMITER
MXR
D 136-4001
103
NOTES:
1. UNLESS OTHERWISE SPEC.
ALL CAPACITOR ARE IN MICRO-
FARADS
ALL RESISTOR ARE IN OHMS
5%, 1/4 WATT.
2. LAST COMPONENT DESIGNATION
FOR C79, CR21, R150, U25, Q8
STEREO
DUAL
POWER
TOP LOOP
BOTTOM LOOP
INPUT
OUTPUT
IN/OUT
RELEASE
ATTACK
SLOPE
CMOS GND
TL072
TL336
4066
4069
5534
2N4126
ZTX109
ZTX108